COMPARATIVE FEEDING BEHAVIOR OF IMMATURE AND ADULT HERRING GULLS

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Many birds do not breed until they are 2 or more years old. Such delayed breeding is generally found among large, long-lived, non-passerine species. Lack (1954) suggested that delayed breeding has probably evolved in species in which reproduction at an earlier age would not be likely to succeed or might be harmful to the parents. Ashmole (1963) and Amadon (1964) suggested that young birds might be unable to catch food as efficiently as adults do. Recently, a number of field studies have shown that the ability to obtain food improves with age (see Buckley and Buckley 1974 for references). Given the inefficiency, it might be expected that the young have to compensate somehow for their lack of success, e.g. by spending more time in feeding. The object of this study was first to establish feeding efficiency in young and adult Herring Gulls (*Larus argentatus*), which show delayed breeding, and then to see how the young make up for any inefficiencies.

The study was made on Walney Island, Cumbria, England, in 1973 and 1974. Herring Gulls and Lesser Black-backed Gulls (*L. fuscus*) breed on the southern end of the island. The colony is very dependent on nearby food sources such as the large intertidal areas of Morecambe Bay and a garbage dump on the island.

METHODS

At low water during spring tides extensive mussel (*Mytilus edulis*) beds are exposed in Morecambe Bay. Associated with the mussels is the common starfish (*Asterias rubens*). Large numbers of Herring Gulls of all age classes fed upon these starfishes. Because of the distance between my observation post and the nearest beds (ca. 400 m) I could only distinguish (I used a 20–45 × zoom scope) between adults and immature birds (all those showing brown feathers). The immatures included birds at least 1 year old and older. The exact number of birds under observation is unknown as birds arrived and left continuously. At any one time approximately 50 birds were present, mainly adults. The gulls fed on starfishes (not mussels) by plunge diving for them, sometimes disappearing completely under water. Both immatures and adults fed in the same water apparently under similar conditions and in similar places. When I saw a gull diving I recorded whether it was successful (emerging with a starfish) or unsuccessful, and what the subsequent fate of the starfish was. Because the period when starfishes were available was short (about 2 hours) and infrequent (only during spring tides), I recorded as many dives as possible (different birds) rather than watching individuals over a period of time. Under these circumstances I could not obtain information on diving rates. Neither was it feasible to obtain meaningful information on the size of the starfishes taken. The data were collected during 25 hours between 3 and 21 April 1973.

On 5 and 6 April 1974, Hans Kruuk and I watched Herring and Lesser Black-backed gulls feeding at low tide on the crab, *Hyas araneus*. Gulls that managed to get a crab were often pursued by others in aerial chases. On both days we counted all the gulls feeding in a small bay, and the proportion of the various age classes represented. For each chase we recorded the number, the species, and the age classes participating as pursuers as well as the age class and the species of the pursued bird. In addition we noted whether the pursued bird lost its prey, and if possible, which pursuer obtained it. We distinguished between first-year-birds (brown young of the previous year), subadults (those showing a mixture of first-year and adult coloration), and adults. Subadult Lesser Black-backed Gulls were not seen in the general area of the colony until 19 April. We therefore assumed that all first-year-birds and subadults in our sample were Herring Gulls. In the analysis, chases in which one or more Lesser Black-backed Gulls pursued another of their species were not included. I did include those Lesser Black-backed Gulls that were chased by Herring Gulls and those that chased jointly with Herring Gulls.

On 3 occasions at low water during spring tides an assistant and I counted all the gulls feeding in Morecambe Bay. The counts were made when the birds returned to the colony. We sat on the shore between the colony and the mussel beds and each of us counted the gulls that flew through his half of the sky. After 15 min I recorded our scores and the counting began anew. This was repeated until almost all gulls had returned to the colony.

RESULTS

Adult Herring Gulls were more successful in catching a starfish on the first dive (18 [64%] out of 28 dives) than immatures (3 [16%] out of 19 dives). These results are significantly different ($\chi^2 = 8.16$, d.f. 1, $P < 0.01$). This has been shown too for the Brown Pelican (*Pelicanus occidentalis*) (Orians 1969) and the Sandwich Tern (*Sterna sandvicensis*) (Dunn 1972), but not for the adult and juvenile Royal Tern (*S. maxima*) (Buckley and Buckley 1974).

Following a successful dive many starfishes were dropped in being brought up from the bottom, or in flight during transport from the water to the land. The gulls often did not attempt to retrieve these starfishes, perhaps because they fell in deep water. Many others were stolen when a diving gull surfaced or while it was being pursued in flight. In cases where they were not pursued in flight, adult Herring Gulls ($N = 28$) dropped 3 out of 28 starfishes, while immatures ($N = 6$) dropped 3 out of 6. These results are not significantly different ($P = 0.053$, Fisher exact probability test). Immature Royal Terns drop significantly more fish than adults do (Buckley and Buckley 1974), and Dunn (1972) suggests the same for Sandwich Terns.

On the mussel beds a gull could lose its starfish when supplanted, when occupied defending a starfish by long-calling (Tinbergen 1959), or when a third bird took it while the owner was busy chasing another gull. The proportion of starfishes eaten versus those not eaten (Table 1) by adult and immature birds is not significantly different ($\chi^2 = 1.65$, d.f. 1, $P > 0.05$). I

Table 1

Differences between Adult and Immature Herring Gulls in the Fate of a Starfish once it is Caught by Diving

Fate of starfish	Adult Herring Gull	Immature Herring Gull
Eaten	28 (36%)	1 (10%)
Dropped	26 (33%)	4 (40%)
Stolen	23 (30%)	4 (40%)
Abandoned	1 (1%)	1 (10%)

think that this is only because my sample for the immatures is small (Table 1). I gathered data only on those birds that were actually seen to dive. Many cases where birds were seen to be feeding on the beds without my knowing how they had obtained their starfish in the first place, went unrecorded. I gained the impression from these additional observations that young birds were more prone to have their starfish stolen than adults.

Many gulls feed in Morecambe Bay at low water during spring tides. For instance, on 20 April we counted 20,473 gulls returning to the colony. In Fig. 1A this count is plotted in relation to low tide. Similar counts were made on 3 May (19,142 gulls) and 4 July (20,304 gulls). Considering the short time that the mussel beds are exposed it is doubtful that any of these gulls had enough time to make more than 1 trip. Each of the 3 curves in Fig. 1A has a major and a minor peak. The medians of any 2 curves in Fig. 1A are not significantly different.

During preliminary counts prior to 20 April I had noticed that adult Lesser Black-backed Gulls and immatures tended to return to the colony later in relation to low tide than did adult Herring Gulls. To analyze this I counted the proportion of immatures in 500 gulls of both species that flew past me. Once 500 gulls had been counted I repeated the procedure until almost all gulls had returned to the colony. For each 500 gulls I recorded the period over which the count was obtained and the midpoint of the period was entered in Fig. 1B. The same procedure was used to obtain a curve (not shown) for the proportion of adult Lesser Black-backed Gulls among all gulls returning to the colony. I used this information to analyze the species and age composition of the returning birds. For instance, the curve of 20 April (Fig. 1A) is redrawn in Fig. 1C. Clearly, the minor peaks (Fig. 1A) referred to earlier are the result of the later return of Lesser Black-backed Gulls, and immatures of both species.

In an aerial chase a bird carrying a crab could be pursued by 1 to 9 other gulls. Although relatively few first-year-birds were present, they participated

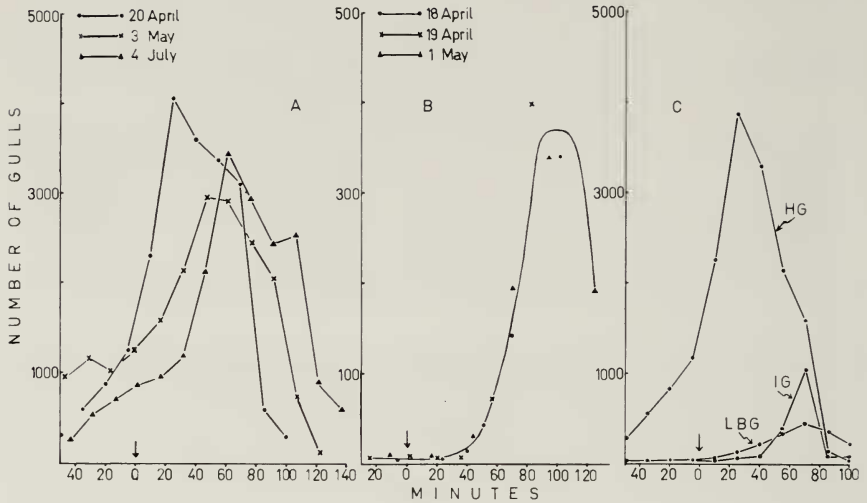

FIG. 1. Number of gulls returning from the mussel beds to the colony plotted in relation to low tide (↓). (A) Each point on the graph is placed in the middle of a 15-min period and indicates the number of all gulls returning during that time span. (B) The number of immature Herring and Lesser Black-backed gulls per 500 gulls of all ages counted for each point on the graph. (C) Adult Herring Gulls (HG), adult Lesser Black-backed Gulls (LBG), and immature gulls (IG) of both species. See text for further explanation.

in many more chases per bird than adult Herring Gulls (Table 2). Of the 82 recorded chases, 67 involved 1 or more of the 39 immatures present. Of the 111 adult Herring Gulls 1 or more participated in only 24 chases. Comparing the number of successful pursuers (i.e. those birds that managed to obtain the prey from the bird they were pursuing) with the number of birds involved as pursuers (Table 2), all 3 age classes of Herring Gulls scored equally well ($\chi^2 = 0.982$, d.f. 2, $P > 0.05$).

Per bird, adult Herring Gulls were pursued significantly less than immature birds ($\chi^2 = 25.31$, d.f. 1, $P < 0.001$). All 3 age classes of the Herring Gull were equally successful in keeping their catch while being pursued ($\chi^2 = 0.39$, d.f. 1, $P > 0.05$).

DISCUSSION

Herring Gulls feed on a variety of foods in diverse places, including the intertidal, harbors, fields, and garbage dumps. The kinds of food obtained there require different types and degrees of skill. Starfishes are an important source of food as judged by the many birds that catch them and by the

TABLE 2

AERIAL CHASES IN A KNOWN NUMBER OF HERRING GULLS AND THE FREQUENCY WITH WHICH EACH AGE CLASS IS PURSUED AND TAKES PART AS PURSUER

		Pursuing birds			Pursued birds		
Age class	No. of birds present	No. of times pursued	No. of times pursued/ birds present	Successful pursued bird[1]	No. of times involved as pursuer	No. of pursuits/ birds present	No. of successful pursuers[2]
First year	10	15	1.5	11	31	3.1	5
Subadult	29	21	.7	14	70	2.4	8
Adult	111	19	.2	10	30	.3	6

[1] Those birds that managed to keep their prey.
[2] Those birds that managed to obtain the food from the bird they were pursuing.

large amounts of calcarious remains found in the colony (Shaffer 1971, pers. obs.). Young birds should thus learn to catch them and this study shows that they do. To make up for their lack of success, several alternatives are possible. For instance, the young may try harder by spending more time diving, by diving more frequently, by being more persistent in diving repeatedly for the same starfish until successful, or by feeding on other types of food as well (i.e. by being generalists). These important aspects could not be studied under the circumstances. One other way of making up for their shortfall in obtaining food is to resort to stealing, either on the ground or in the air.

In this study the immatures participated in a greater number of pursuits than one would have expected from the number of immatures present (Table 2). Adult Herring Gulls do not chase others as much as do immatures (Table 2). Apparently as the young mature, chasing becomes less important as a way of obtaining food. There may be several reasons for this. Adults may be less successful as chasers than younger birds, but this was not the case. Secondly, adults may give up sooner than immatures and very short chases involving adults may thus go unrecorded. Some evidence from aerial chases over the garbage dump in Oxford, England, in winter shows that young birds were as tenacious as adults. Apparently, the propensity of immature Herring Gulls to steal is real (Drury and Smith 1968). Moyle (1966) reports similar observations for immatures of *Larus glaucescens*.

Because of their general inefficiency, it seems reasonable to assume that the immatures require more time than the adults to satisfy their food requirements. This is indirectly supported by the fact that most of the immatures returned to the colony later than most of the adult Herring Gulls, the bulk of which returned 45 min earlier than the immatures (Fig. 1C).

The data suggest that at any given age a Herring Gull employs mostly those feeding skills that produce the best results. As the birds mature they learn new skills, improve on them, and discard or de-emphasize others. For an immature Herring Gull stealing on the ground and in aerial chases is apparently important. However, the young spend some time learning the feeding skills used by adults. Older birds do not chase as much as younger ones and I assume that for them other forms of feeding are more efficient in terms of time and energy expenditure.

SUMMARY

Immature Herring Gulls are less efficient in capturing starfishes by diving and possibly also in transporting them in flight than are adults. In contrast to the adults, the immatures steal much of their food from other gulls on the ground and in aerial pursuits. As the birds mature, stealing gives way to independent methods of finding food.

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REQUEST FOR ASSISTANCE

WANTED: Data on the Seasonal Distribution of North American Gulls.—We are developing a procedure whereby the U.S. Air Force can predict the potential seasonal hazard to aircraft represented by gulls in parts of North America. This knowledge will be used to schedule missions around high risk areas thereby reducing the likelihood of bird-aircraft collisions. Supplemental data on local gull populations are needed from all parts of the continent. The assistance of field workers is solicited to aid us in this task.

For each observation, please provide the following information: list of species present, approximate number of each species, precise locality description, dates observed, any information about causes for concentrations (e.g. sanitary landfill operation), and any details about the frequency of such concentrations in the respective areas. Information is sought from inland as well as coastal localities.

Please submit reports of your gull observations to Dr. William E. Southern, Department of Biological Sciences, Northern Illinois University, DeKalb, IL 60115. Data will be gathered for a 2-year period beginning 1 September 1977.